A brief contribution to the history of the genus *Bacillus* in Sicily

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Abstract

Some short notes on the presence of the genus *Bacillus* (Insecta, Phasmatodea, Bacillidae) in the Italian peninsula and particularly in Sicily. The present paper recounts the vicissitudes that led to the discovery of new taxa in the 1980s; provides an outline of their distribution, with notes on the relationships between the different species and a further account of their reproduction modes. Finally, excursions to the Iblean region (south-eastern Sicily) and Marettimo Island (Egadi Archipelago) are described, and future trips and study projects are suggested.

Key words

Bacillus, Sicily, Iblean region, Amphigonic, Hybrid, Parthenogenesis, Hybridogenesis, Gynogenesis, Androgenesis, Species, Endemic, Extinction, Rearing, Biodiversity.

Introduction

Up to the 1960s, only one amphigonic (sexually reproducing) population of *Bacillus rossius* (Rossi, 1788) in the Italian peninsula was recorded in the literature (Montalenti & Fratini, 1959) and was located in Campania. Italian researchers subsequently noted some further findings in Liguria and Tuscany (Marina di Pisa), where both amphigonic and parthenogenetic populations were living. With regard to *B. rossius*, some authors noted various sub-species defined on electrophoretic and ootaxonomic bases; two of these are recorded in Italy (see Figure 1). *B. rossius rossius* is located along the Tirrenic coasts (the coastlines of Liguria, Tuscany, Sardinia, Campania and Lazio), and in a small area at the river Po delta, while *B. rossius redtenbacheri* lives along the entire length of the Adriatic and Ionic basins and at the tip of the Italian peninsula (Calabria, Apulia, Basilicata), including Sicily, the Eolie Islands and a small area in southern Sardinia (see Figure 2 for a view of the Italian Districts).

Recently described taxa in Sicily

Prior to 1980 only *B. rossius* and *Clonopsis gallica* (Charpentier, 1825) were known from Italy and there was a considerable amount of confusion among dealers and breeders of insects. When the efforts of researchers concentrated on southern Italy (and in particular on Sicily) in search of bisexual stocks of *B. rossius*, they soon found themselves confronted with some new species of stick insects. Within a short time period, in the Iblean region of south-eastern Sicily, *Bacillus grandii* (Nascetti & Bullini, 1982), *Bacillus whitei* (Nascetti & Bullini, 1982) and *Bacillus lynceorum* (Bullini, Nascetti & Bianchi Bullini, 1984) were described. Holotypes of new Sicilian stick insects are kept at Natural History Museum "Giacomo Doria", Genoa, Italy. The first species immediately aroused interest because it was bisexual, in the same manner as *B. rossius*. The others two species were hybrids and the interest of the researchers was stimulated by their reproductive mechanisms, because it was clear they were genetically free from the progenitor taxa (species which have originated the hybrids).

Parthenogenesis, the embryonal development in the egg without the participation of the male, was first noted in *Bacillus* as far back as the beginning of the 1930s, thanks to observations made by a group of French researchers that included Cappe de Baillon, de Vichet and Favrelle (Benazzi, 1946). These authors carried out a series of experiments by crossing females of *B. rossius*, which in France is a parthenogenetic species only because males are very rare (de Vichet, 1944), with males of the same species collected from the Algerian coasts in bisexual populations (Favrelle & de Vichet, 1937). So-called "geographic parthenogenesis" was presumed to take place in regions with cold climates. Later, this assumption was contradicted by the discovery of parthenogenetic populations in areas, such as the Iblean region, where the climate would seem to favour amphigonic populations. From the 1960s onwards, the Italian zoologists and cytogenetists Mario Benazzi (initially) and

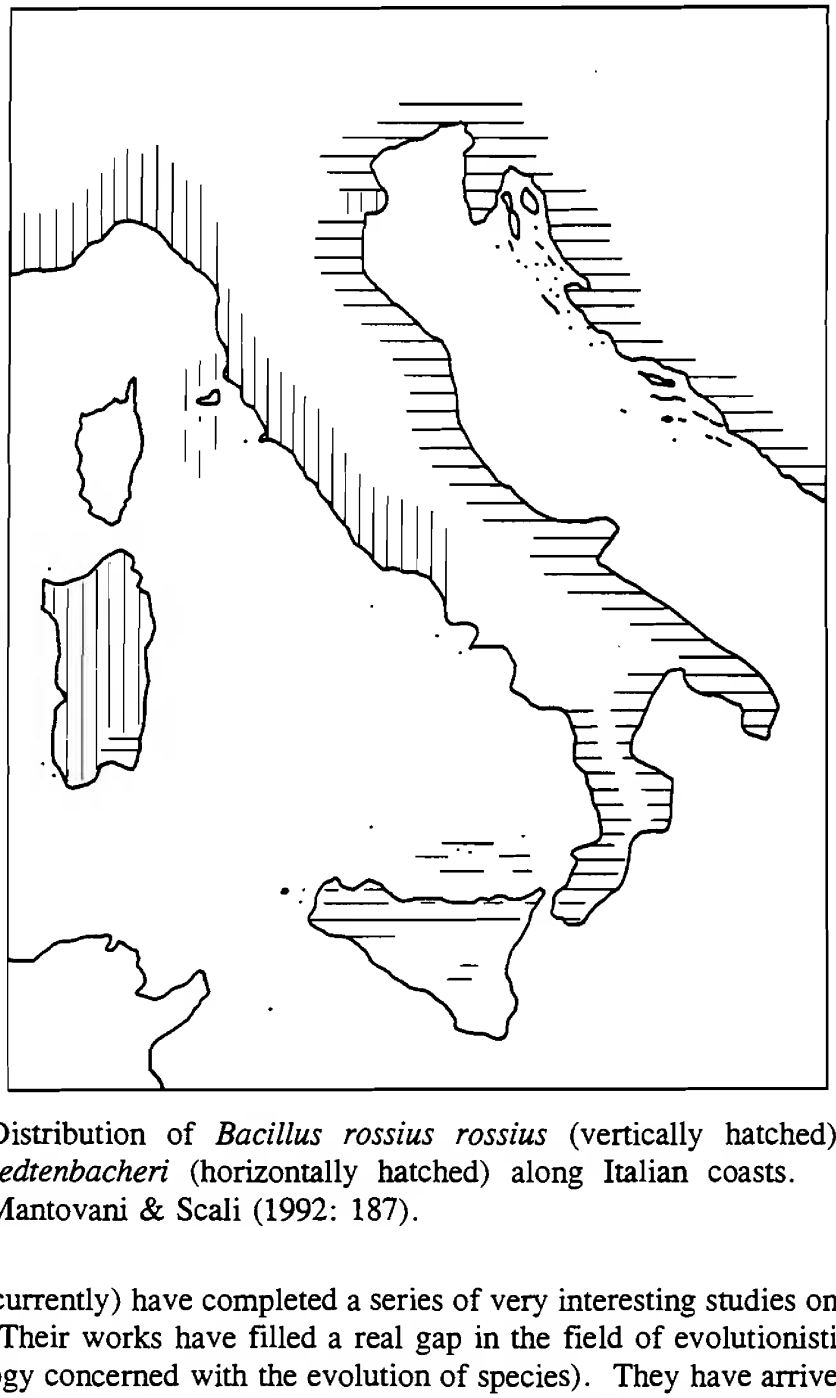

Figure 1. Distribution of *Bacillus rossius rossius* (vertically hatched) and *B. r. redtenbacheri* (horizontally hatched) along Italian coasts. After Tinti, Mantovani & Scali (1992: 187).

Valerio Scali (currently) have completed a series of very interesting studies on the Italian and Sicilian taxa. Their works have filled a real gap in the field of evolutionistic biology (that branch of biology concerned with the evolution of species). They have arrived at some very important and unexpected conclusions with respect to the "ecological niches" of some species and the complex genetic relationships of others.

B. grandii, apart from inhabiting the Iblean region, is also found in western Sicily and in the Egadi Archipelago, with two different sub-species situated along the coast near Trapani and in the islands of Levanzo and Marettimo: *B. grandii benazzii* and *B. grandii maretimi*. In the light of these discoveries, the range of the species was further extended. It is the Scali's opinion (1991) that this fact opens up the possibility that *B. grandii* could be the "ancestor" of the holo-Mediterranean (i.e. of the entire Mediterranean basin) forms of the genus *Bacillus*, as was believed until some years ago. This "theoretical taxon" (certainly *grandii*-like) must be located more towards the west of the Mediterranean basin or it may even be extinct.

B. grandii grandii, the Iblean sub-species, is a restricted endemic and through a series

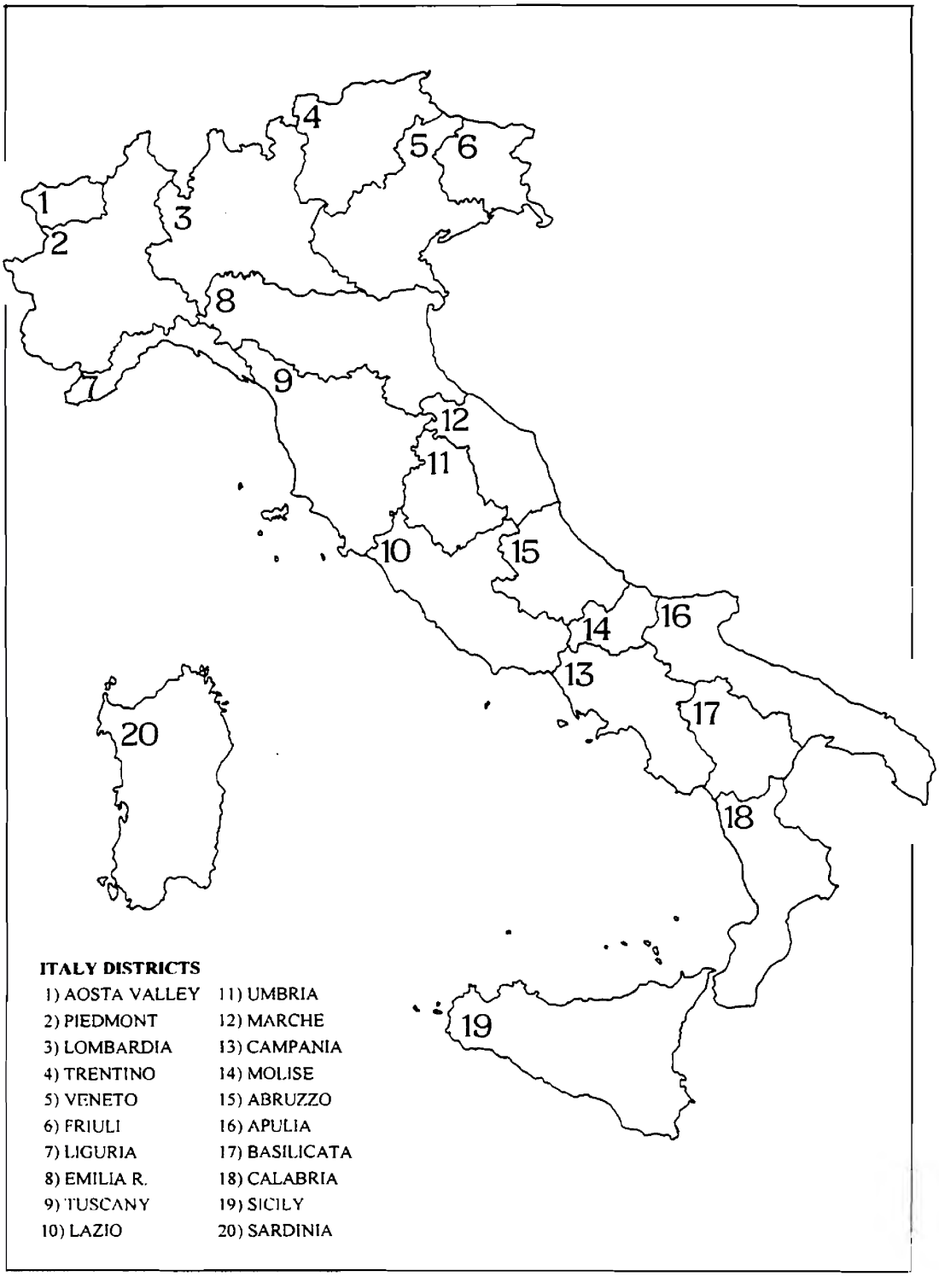

Figure 2. Districts of Italy.

of attendant circumstances is itself at risk of extinction. It is located in just a few habitats near Palazzolo Acreide, Canicattini Bagni and Floridia, in the province of Syracuse. Each of these habitats of *B. grandii grandii* harbours only a small number of specimens and the human presence represents a continuous threat, especially considering the local custom of burning or drastically trimming hedges, the only refuge for phasmids. The second major aspect creating the risk of extinction in *B. grandii grandii* is the incessant competition with

the sympatric (two or more species which live together) *B. whitei* with which it mates regularly, as confirmed by Scali, Mantovani and Tinti (1991: 104). This fact causes a substantial waste of the insects' reproductive potential, only partly balanced by the sex ratio in favour of males.

B. whitei, a hybrid of *B. rossius redtenbacheri* and *B. grandii grandii*, has lately been the subject of some interesting studies that have thrown light on its genetic characteristics. Such characteristics mean that *B. whitei* is a taxon that is unique in the whole of the animal kingdom. By means of a series of crosses with the three sub-species of *B. grandii*, researchers have found the contemporaneous presence of parthenogenesis, hybridogenesis and gynogenesis, and have also reported occasional cases of androgenesis (Scali, Mantovani &

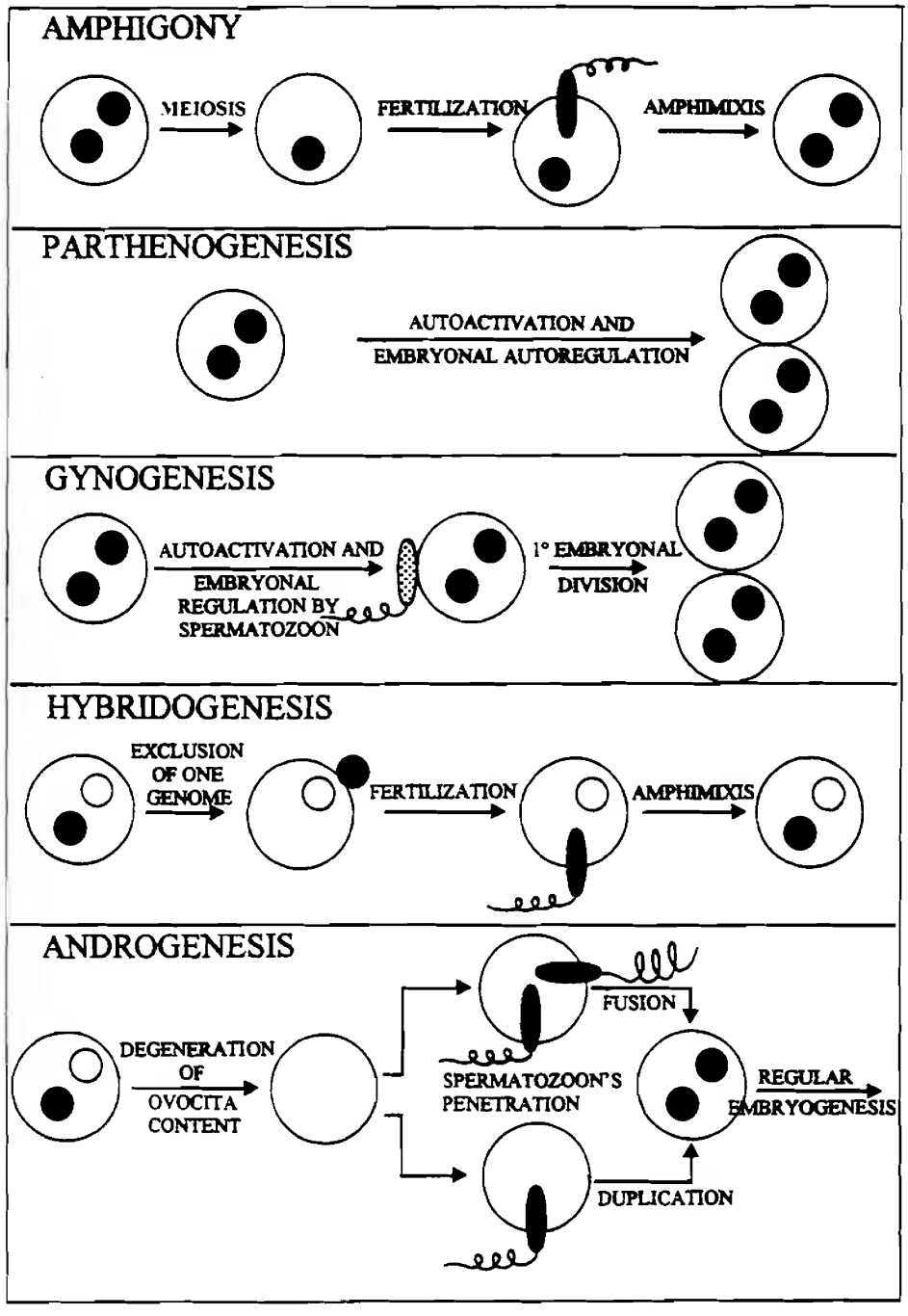

Figure 3. Reproduction modes in the genus *Bacillus*; after Tinti *in* Veroli (1995: 26).

Tinti, 1991) (see Table 1 and Figure 3 for a general scheme of reproduction modes in the genus *Bacillus*).

This is the first practical confirmation of the evolutionistic theory put forward by some authors on hybridogenetic organisms. For this reason, this representative of Iblean fauna takes on enormous importance, as it testifies to the genuine possibility that an amphigonic organism, evolved to the hybridogenetic stage, might select parthenogenesis as a further adaptation. This is also important because, for the first time, hybridogenesis is being considered as a vital genetic-evolutionistic adaptation. This could have highly interesting reverberations for other animal classes and call for renewed discussion of the very idea of "species" (Veroli, 1995).

B. lynceorum, the longest species in the genus, is the triploid *rossius-atticus-grandii*, probably a cross between *B. grandii grandii* and a diploid F1 hybrid *B. atticus x B. rossius redtenbacheri* which (unusually) produced fertile eggs (Brock, 1991: 20; Manaresi *et al.*, 1992).

In the 1980s, together with the discovery of new Sicilian taxa, some further locations in Italy for *Bacillus atticus* Brunner von Wattenwyl, 1882 were discovered, which was previously only recorded from Attic, Epirus and Peloponnese (in Greece) according to Nascetti and Bullini (1982), La Greca (1984, 1996a), Agostini and Scali (1989) and on the Dalmatian coasts (Müller, 1957). During the Pleistocene era (La Greca, 1996a), this taxon arrived in the Iblean region by crossing what is now Apulia and Calabria and spread throughout the whole of Sicily. In fact, the micro-plate of African origin that formed the Iblean region, during the Pliocene era, was again separated from the north of Sicily (see Figure 4). *B. atticus* on the Italian coasts displays a genetic differentiation from its counterpart in Greece and in the Dalmatian area. In 1982, the researchers Nascetti and Bullini named the Italian population as new sub-species *B. atticus caprai*. Strangely, this subspecies is not cited in Failla *et al.* (1994).

Species	Mode of reproduction
Bacillus rossius	amphigony (*), parthenogenesis (**)
Bacillus atticus	parthenogenesis
Bacillus grandii (***)	amphigony
Bacillus whitei	parthenogenesis, hybridogenesis, gynogenesis androgenesis
Bacillus lynceorum	parthenogenesis
Bacillus rossius-grandii grandii	hybridogenesis, androgenesis
Bacillus rossius-grandii benazzii	hybridogenesis, androgenesis, gynogenesis

Table 1. Reproduction modes in the Italian representatives of the genus *Bacillus*. (*) Central and southern Italy; (**) Central and northern Italy; (***) All three subspecies of the taxon.

Of additional interest were the findings of specimens of the natural hybrid *Bacillus atticus-rossius,* along the coast near Alimini, in Apulia. However, these insects are completely sterile. Again, with respect to the Sicilian phasmids, it is doubtful whether the two inter-species hybrids *B. rossius-grandii grandii* of the Iblean region and *B. rossius-grandii*

benazzii of north-west Sicily should really be considered species in every respect. In accordance with the interpretation given in the recent "*Checklist delle specie della fauna italiana*" (Failla *et al.*, 1994: 19-20) - probably the most authoritative reference among those cited - authors are inclined to assign the status of species, at least temporarily (these hybrids are in course of study), although these populations seem to be unable to maintain themselves without continuous crosses with the progenitor taxa. In fact in zoology a species is the basic unit: an individual entity of a population, the members of which show the same chromosome complement; they are able to reproduce themselves, giving origin to fertile progeny; such progeny must be able to maintain themselves. (See Figure 5 for a general view of the Sicilian taxa's distribution).

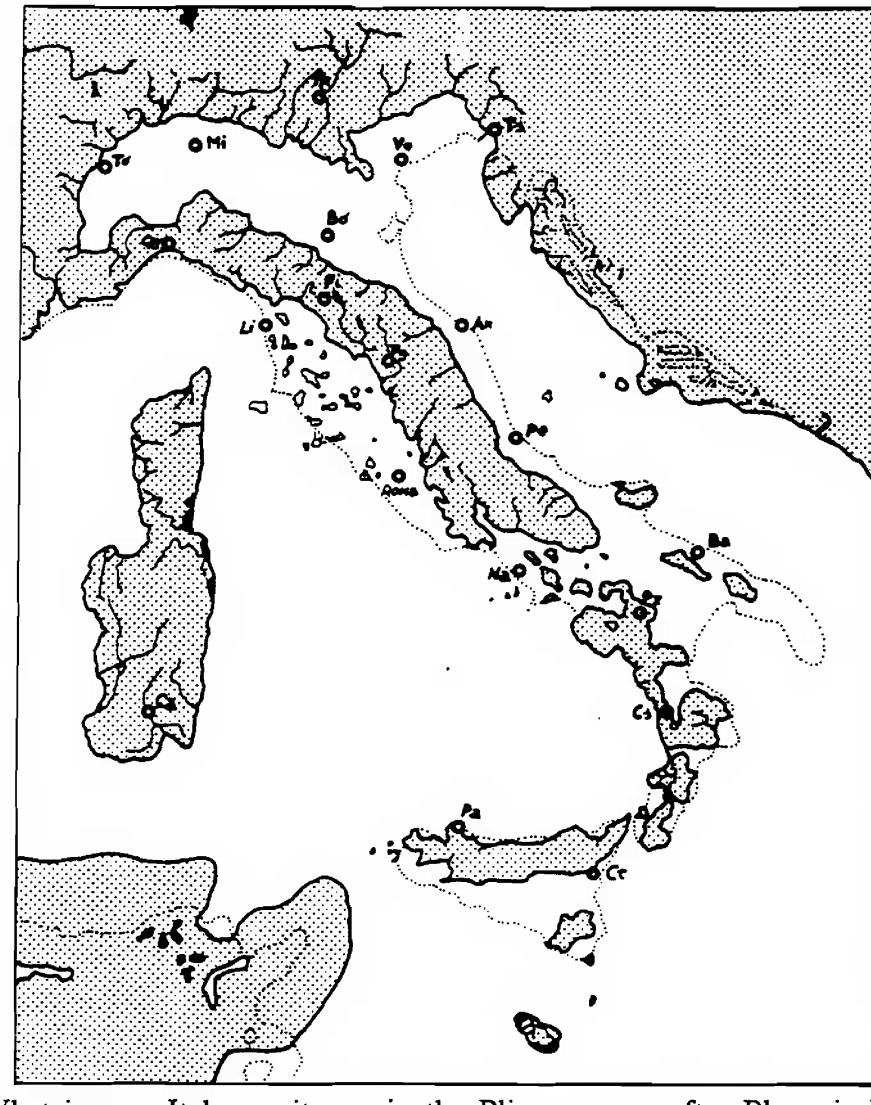

Figure 4. What is now Italy, as it was in the Pliocene era; after Blanc *in* La Greca (1996a: 24).

Notes on two preliminary excursions to Sicily - October 1996

In October 1996, in collaboration with the *Ente Fauna Siciliana*, some adult specimens of *B. whitei* (see Figure 6) were found, at night, near Isola Coco, alongside the old Syracuse-Vizzini-Ragusa railway, on some bramble plants (*Rubus* spp.). The plants were in the undergrowth, near the river Anapo. Although very common in the Iblean region, *B. whitei*

had never been recorded as inhabiting this area. The only record in the scientific literature for the Anapo Valley seems to have been in Bullini and Nascetti (1987), but this is for the genus *Clonopsis*. Some specimens of *B. whitei,* collected for study, are at present being kept in captivity at room temperature and under natural photoperiod. Attempts are being made to understand its capacities for adaptation and longevity in captivity. With respect to foodplants for rearing, Scali (1991: 403) suggests that a mixed diet of bramble and lentisk could be the best solution for *B. grandii*. Other specimens of *B. whitei* were collected in a bramble-bush in the suburbs of Palazzolo Acreide (province of Syracuse). During a further excursion along the road between Canicattini Bagni (province of Syracuse) and the cross-road for Palazzolo Acreide, some specimens of *B. lynceorum* were collected. This species is easily recognizable thanks to its remarkable size (up to 105mm in length), the clear granulation of its meso and metathorax, its stocky cerci and the typical notch at the distal end of its subgenital plate. *B. lynceorum* is also exclusively endemic to the Iblean region.

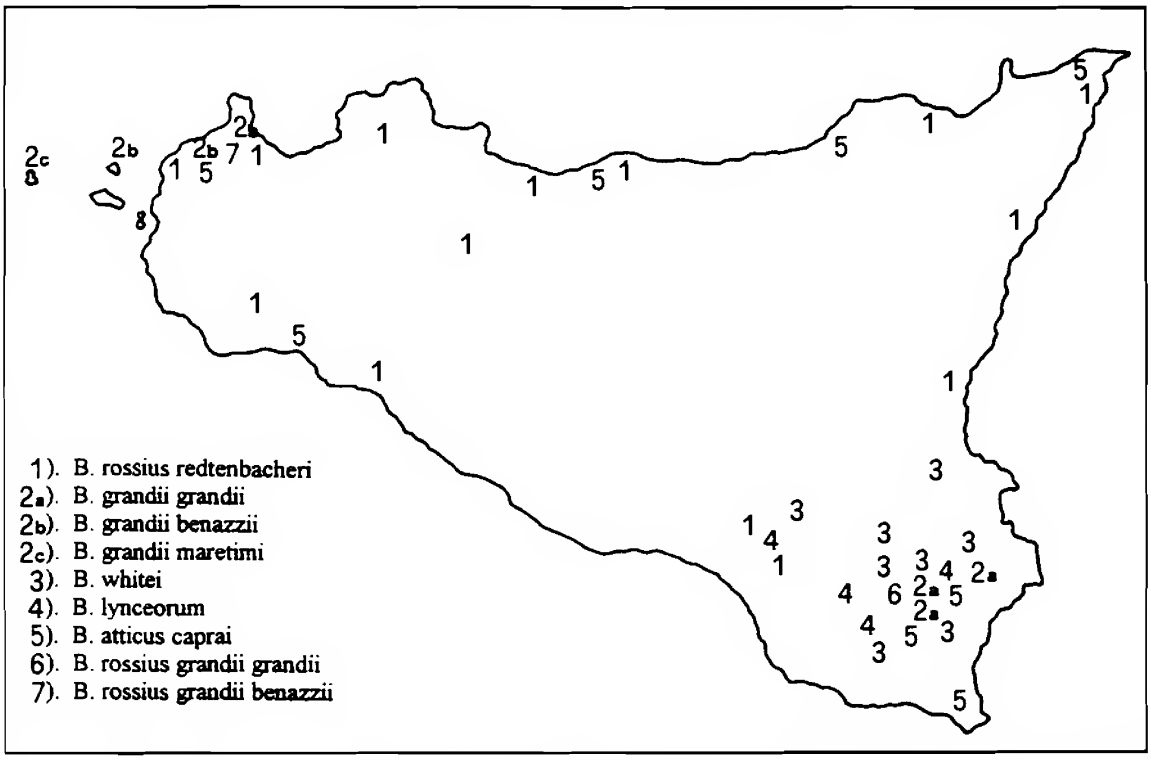

Figure 5. Distribution of *Bacillus* spp. in Sicily; after Montovani & Scali, as modified by La Grece (1996a: 32).

The trip to the Iblean region came to an end in western Sicily along the Trapani coast, between the localities of San Vito Lo Capo and Scopello where *B. grandii benazzii* were noted and in Marettimo (Egadi Islands) where *B. grandii maretimi* (see Figure 7), is found. During an excursion in Marettimo several green nymphs (at first and second instar) of *B. grandii maretimi* were found on lentisk. These two sub-species, in fact, feed only on lentisk (*Pistacia lentiscus* Linnaeus), in contrast with *B. grandii grandii* of the Iblean mountains which feeds principally on bramble (*Rubus* spp.) or plants of *Rosa* spp.

Studies and prospects

With regard to the Iblean region (see figure 8), the author plans for 1997 foresee a more detailed study along the Anapo and Cassibile rivers in search for new habitats of *B. whitei,*

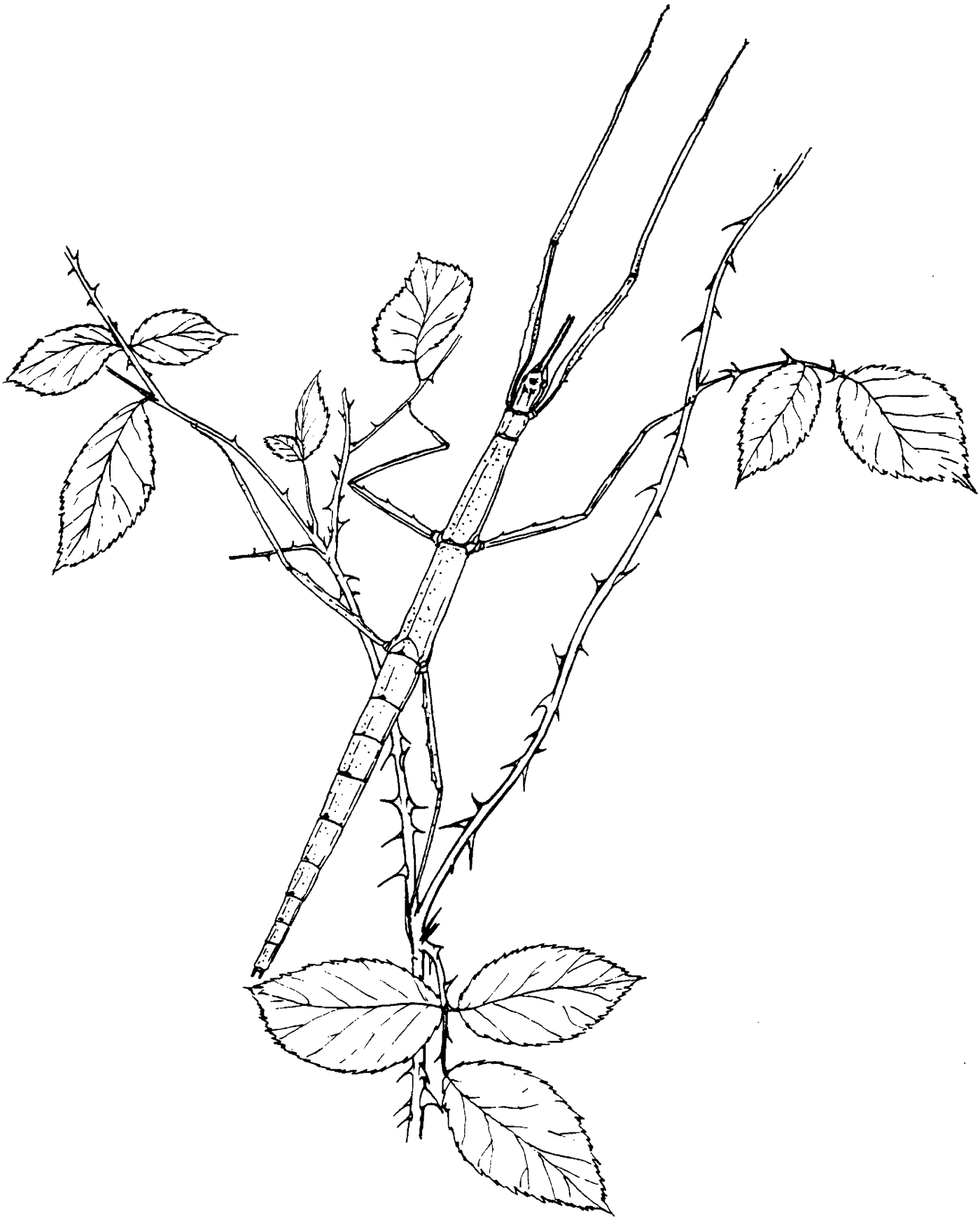

Figure 6. Female *Bacillus whitei* on bramble.

B. lynceorum and the hybrid *B. rossius-grandii grandii*. It is very difficult to recognize this hybrid because it is morphologically similar to *Bacillus whitei* (Failla *et al.*, 1994: 22). This taxon, doubted by some authors, is different from *B. whitei* in being hybridogenetic as opposed to parthenogenetic. Consequently, while *B. whitei* is completely free of males of *B. grandii grandii* for purposes of reproduction, *B. rossius-grandii grandii* requires continuous crosses with "progenitors".

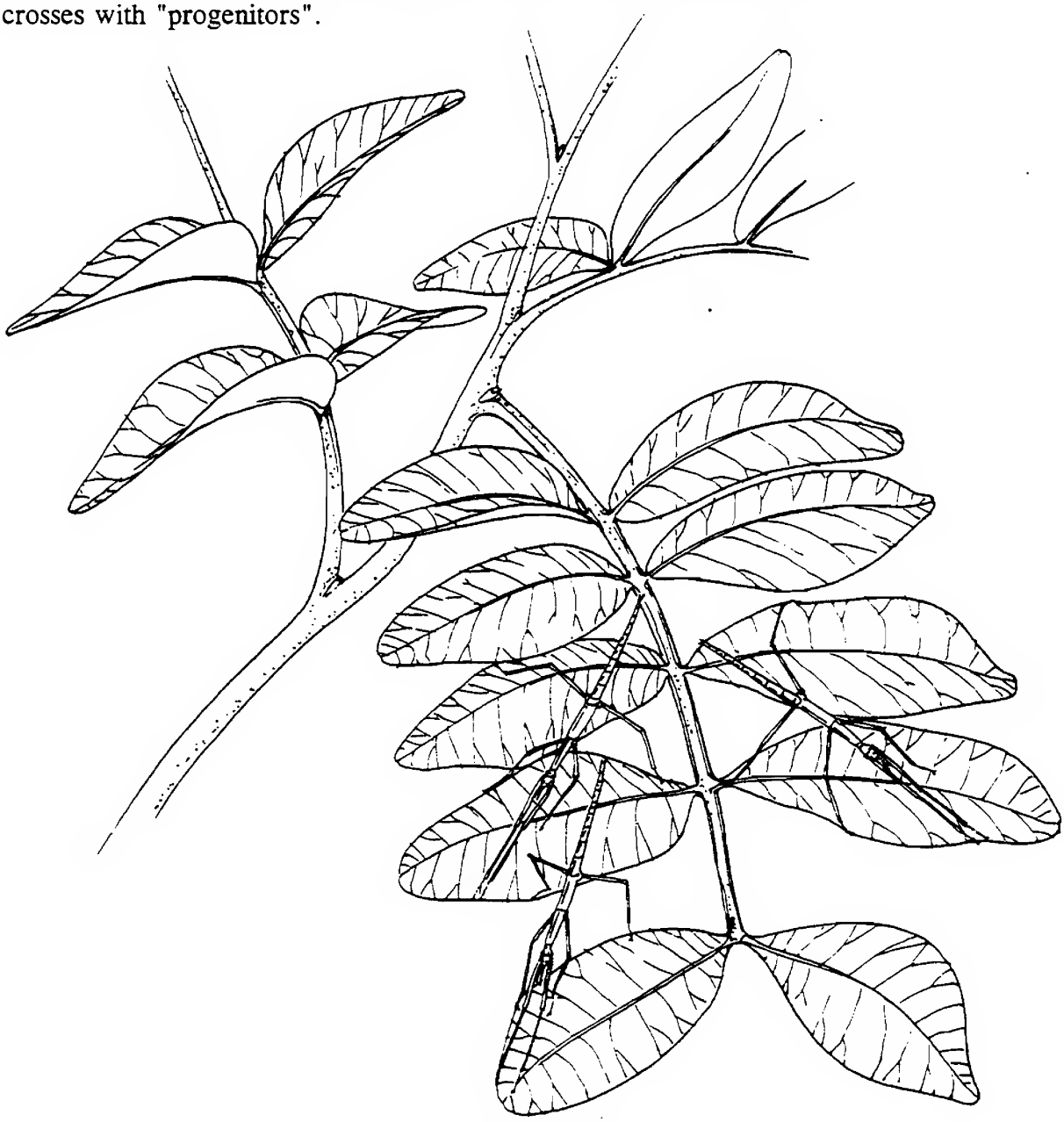

Figure 7. *Bacillus grandii maretimi*, three nymphs on lentisk.

A second - and no less important - purpose concerns the conservation of the taxon *B. grandii grandii*. As previously stated, this species is in serious risk of extinction. We may assume that the best method of conservation for the taxon is the protection of its environment: hedges of bramble bushes. Unfortunately, the extensive use of fire in order to remove unwanted hedges in the Iblean territory is a cause of death for this insect. If these natural barriers were to be destroyed manually, the insect would at least have the possibility of escape during the night.

The hedge problem has already been discussed in relation to interventions aimed at protecting natural environments, with WWF Italy playing a major role. During the early 1990s, several thousand shrubs of *Prunus, Myrtus, Rubus, Cistus, Pyrus, Crataegus, Rosa, Pistacia, Erica* and other characteristic plants of the Mediterranean environment, were planted across Italy. Thus, efforts are being made to revive at least a part of a territory that has been sorely impoverished in earlier decades (Francescato, 1989).

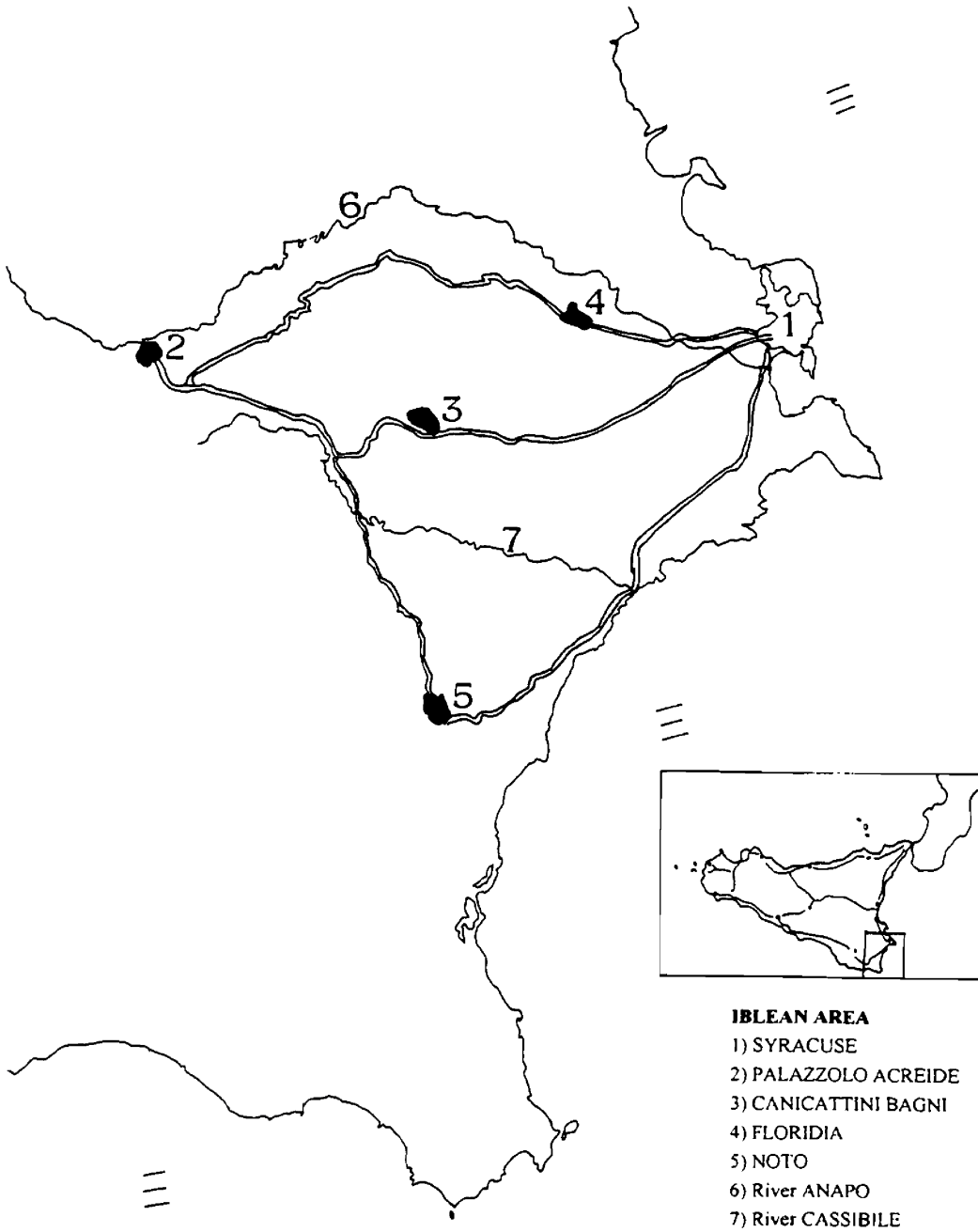

Figure 8. The Iblean area of Sicily.

Biodiversity in a natural environment is the result of a long developmental process. The most precious aspect of the resources in a natural environment is provided by the endemic species, that is, by the living creatures geographically localized and currently at risk of

extinction. It should be remembered that an incidental loss of these species would be an incalculable loss for science and utterly irredeemable (La Greca, 1993, 1996b). The situation in Marettimo is more stable, in contrast with the Iblean region; *B. grandii maretimi* is present in a large numbers and there are currently no obstacles to its survival.

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